

to produce a hybrid which contains 24 chromosomes from parent *A* and 24 from parent *B*. Reduction division by this hybrid should produce gametes of numerous types, ranging from those which would possess the 24 chromosomes of the *A* parent and none of the *B* chromosomes, to the other extreme in which the reverse would be true. It is assumed that gametes in the intermediate condition, with a liberal mixture of *A* and *B* chromosomes, fail to develop. "Any gamete containing elements derived from both systems would give a reaction system subject to profound disturbances incident upon the inharmonious relations set up" between the *A* and *B* elements. In consequence the only gametes which successfully develop are such as contain all or almost all of the *A* chromosomes, or all or almost all of the *B* chromosomes. This hypothesis of selective survival of the gametes produced by the  $F_1$  species hybrid is supported by the following very striking facts. Back crosses with either parent result in the production of a relatively much higher number of forms identical or almost identical with that parent than would otherwise be expected. Also, in the scanty  $F_2$  generation which it is sometimes possible to obtain, many more individuals appear which are identical or almost identical with the original grandparents (*A* and *B*) than would otherwise be expected.

SAX<sup>7</sup> arranges the species of *Triticum* in three groups, characterized by haploid chromosome numbers of 7, 14, and 21 respectively. Crossing within the groups produces fertile hybrids, but crossing between the groups results in more or less sterile hybrids. It is noteworthy that the  $F_1$  endosperms are well developed in the fertile crosses, but shriveled in those crosses which are to produce sterile or partially sterile  $F_1$  plants. In all cases, however, hybrid vigor appears in the vegetative parts of the  $F_1$  plants. Evidently endosperm development as well as gametogenesis is sensitive to the disturbances resulting from the union of "inharmonious" gametes. The  $F_2$  results of SAX,<sup>8</sup> however, appear not to agree with the ideas of the other investigators, since in this generation no greater sterility appears in the intermediates than in the segregates resembling the grandparents. Ecologists as well as geneticists will be interested in the natural law which is suggested by this work of SAX. In a group of species of which the chromosome numbers vary in multiples of an original basic number, adaptability varies directly with the chromosome count. Thus the 21 chromosome wheats are the most adaptable, and the 7 chromosome wheats are the least adaptable.—M. C. COULTER.

**Fusarium resistant cabbage.**—The selection of *Fusarium* resistant strains of cabbage is being continued at the Wisconsin Experiment Station by JONES<sup>9</sup>

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<sup>7</sup> SAX, KARL, Sterility in wheat hybrids. I. Sterility relationships and endosperm development. *Genetics* 6:399-416. 1921.

<sup>8</sup> SAX, KARL, Chromosome relations in wheat. *Science* 54:413-415. 1921.

<sup>9</sup> JONES, L. R., WALKER, J. C., and TISDALE, W. B., *Fusarium* resistant cabbage. *Wis. Agric. Exp. Sta. Res. Bull.* 48. 1-34. *figs.* 10. 1920.

and others. In an earlier report<sup>10</sup> the symptoms of the yellows disease of cabbage are described. It is caused by a vascular parasite (*Fusarium conglutinans*) which persists indefinitely in the soil, eventually forcing abandonment of large areas of fertile soil for cabbage culture. Soil disinfection having proved ineffective or impracticable, the only hope for control lies in the selection of disease resistant strains. Selections have been continued since 1910 with very effective results.

The success of this work rests largely on the fact that the cabbage is nearly self-sterile and is normally cross-pollinated. As a result all standard varieties of cabbage are variable in type to a greater or less degree. Fortunately, moreover, wherever cabbage was grown on soil badly infested with yellows, although a large majority of the plants were killed, always a few showed a high degree of resistance and developed normally. By selection of such heads for seed growing the next season, and saving the seed from each plant separately, individual head strains were secured which were planted on badly infected soil the second season. Thus by continual selection and elimination of weaklings, high resistant strains were quite readily secured.

It should be pointed out that there are numerous horticultural varieties of cabbage adapted to various localities and uses. In making selections for resistance, therefore, the importance of adhering as strictly as possible to the horticultural characteristics of the original type was recognized. Consequently the earlier efforts were directed upon the late or winter type of cabbage, known as Hollander or Danish Ball Head, which is grown most generally in Wisconsin. A highly resistant strain of this variety was secured to which the name Wisconsin Hollander has been given. The latter differs slightly from the original in having a more vigorous plant with a longer stem and flatter head, and in maturing somewhat later. These objectionable features have now been overcome by reselecting from the Wisconsin Hollander an earlier strain with the more desirable qualities of shorter stem and spherical head. For purposes of distinction the former strain is now designated as Late Wisconsin Hollander and the latter as Early Wisconsin Hollander.

Following similar methods, selections from two late summer varieties of the flat head type, the All Seasons and the Brunswick, have yielded highly resistant strains of each. These new strains are known as the Wisconsin All Seasons and Wisconsin Brunswick. To meet further demands of the trade, selections are now under way on three still earlier maturing varieties, the All Head Early, the Glory of Enkhuizen, and the Copenhagen Market.

In general, throughout this work, a number of closely similar seed heads from the same source were grown in mixed plantation to insure sufficient setting of seed. The seed from individual plants was then saved separately and tried out in head to row tests. In certain cases, however, attention was

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<sup>10</sup>JONES, L. R., and GILMAN, J. C., The control of cabbage yellows through disease resistance. Wis. Agric. Exp. Sta. Res. Bull. 38. 1-70. figs. 23. 1915.

given to selfing of individual plants with some success. In order to hasten the work, winter seed growing in the greenhouse or out-of-doors in the southern states was practiced with moderate success.

Seedsmen and growers are interested in the possibility of producing seed of these resistant strains in the commercial cabbage seed growing sections. The difficulty encountered in this procedure lies in the fact that yellows does not occur generally in our seed growing sections. The small percentage of susceptible plants would thus not be eliminated, and tendency toward reversion would be expected. The investigators have studied this question by having a resistant strain grown for one generation in the Puget Sound seed growing section, and then testing it on diseased soil together with Wisconsin grown strains. Little or no reversion was noted when this was carried on for only one generation. The practice, therefore, is being approved for the present provided precautions are taken to supply stock seed each year from plants selected on diseased soil, and to so isolate seed fields as to avoid all possibility of cross-pollination with other varieties.—J. C. WALKER.

**Abnormal behavior in corn endosperm.**—If pollen from red grained corn be applied to the silks of a colorless grained variety, the resulting grains will be red. This familiar phenomenon of xenia is explained by the known facts of double fertilization. This cross, however, may produce a very few aberrant grains; of these, only a part of the surface is red and the rest colorless. Such grains are commonly spoken of as "mosaics," while the terms "mottled," "spotted," and "variegated" usually refer to different phenomena. WEBBER<sup>11</sup> observed this phenomenon, and suggested two possible explanations: (1) the second male nucleus fails to fuse with the female fusion nucleus, and these two elements divide independently in producing endosperm; (2) the second male nucleus fuses with one of the female polars, the other polar dividing independently in the production of endosperm.

The first explanation was disproved by EAST<sup>12</sup> in the following manner. Factors *R* and *C* must be present simultaneously for the production of red endosperm. A cross between the two colorless grained types, *CCrr* and *ccRR*, therefore, will produce a red grained ear. Even here, however, aberrant grains sometimes appear, part of the grain being white and the rest colorless. Failure of the second male nucleus to fuse with the female polar nucleus in such a case would result in a grain which was entirely colorless, a thing which never occurred. It is only by fusion of male and female nuclei that any part of the endosperm can be red.

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<sup>11</sup> WEBBER, H. J., Xenia, or the immediate effect of pollen in maize. U.S. Dept. Agric., Div. Veg. Phys. Path. Bull. 22:1-44. 1900.

<sup>12</sup> EAST, E. M., Xenia and the endosperm of angiosperms. BOT. GAZ. 56:217-224. 1913.